1992

The Spatial Dimension of Time

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Published (as Chapter 11) in *Space, Time, and Archaeological Landscapes,* edited by Jacqueline Rossignol and LuAnn Wandsnider. (New York, Plenum Press, 1992), pp. 257–282.

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> [T]he [jacal habitation] framework is fairly permanent, usually surviving a number of occupancies extending over months or years, and outlasting an equal number of outer coveries; so that all habitable Seriland is dotted sparsely with jacal skeletons, sometimes retaining fragments of walls or roof, but oftener entirely denuded. (McGee 1898:222)

Introduction

Archaeological research commonly focuses on various temporal aspects of archaeological deposits, such as their age and the sequencing or the relative temporal order of one deposit to another. Another aspect is the concern for temporal scale and resolution, or the degree of contemporaneity shared by deposits, treated elsewhere in this volume by Jones and Beck and also by Zvelebil and colleagues.

Archaeology is also concerned with ethnographic time, that domain in which formation events occur. Here, ethnographic temporal aspects refer to the temporal characteristics of activities with respect to the piece of land on which those activities occur. Thus activities can be distinguished according to duration (Chatters 1987; O'Connell 1987; Yellen 1977), degree of planning (Kent 1991), and frequency and syncopation of occurrence, all with respect to a specific location. The last, frequency and syncopation in activities, are part of the larger notion of activity tempo. Binford (1980), Ferring (1986), and others have called attention to the tempo of deposit formation, as contributed by both natural and cultural events, as well as the relationship between deposition tempo and deposit grain.

This chapter focuses on a more general aspect of ethnographic time, the *tempo of locale use,* or the frequency and syncopation with which a specific area (i.e., locale) is occupied. It attempts to relate the differential development of archaeological landscapes to locale use tempo. It suggests that it may be possible to "read" land use tempo through inspection of the spatial distribution and state of contemporaneous archaeological elements within a region. This proposed spatial dimension of time is explored using computer simulation of a general model describing the development of an archaeological landscape. By way of introducing this model, the necessity of archaeologically "reading" tempo is touched upon briefly first.

Economy and Tempo of Locale Use

Economy can be described as a configuration of technology and people on the land surface and through time. Thus it is useful to distinguish between a hunting economy based on the spear versus one employing the bow and arrow or the rifle. It is equally useful to distinguish between bow-and-arrow hunters that hunt only one location during one season versus those in which a single location is hunted year round. Finally, distinguishing between economies in which a single location is hunted sporadically throughout the year versus one in which a single location is repeatedly hunted throughout the year is also useful. When one component of the economy changes, there is, of course, a reorganization in the role played by all the other components. For example, Pelto and Müller-Wille (1987) document the reorganization of social, leisure, and production activities in various arctic groups upon the introduction of the snowmobile.

Locale use tempo, then, informs on the role of that locale, and cultural or natural features there, in the settlement-subsistence system. By amassing data points on tactical locale use for multiple locations in disparate contexts, we approach a fuller understanding of land use strategies. In conjunction with independent, particular data, such as how plants or animals were processed at specific locations and times within the locale, determinations of tempo and tactical land use decisions contribute to the emerging picture of the overall organization of the settlement–subsistence system. In tum, it is this system upon which ecological–evolutionary selection acts (Binford 1981; see also Rossignol this volume). To identify and gauge the effects of selective forces, it is necessary to understand the system that modulates such forces. Understanding land use tempo over the medium and long term, then, takes us one step further in the analytic process of reconstructing past systems (Binford 1982, 1983).

Thus it is critical that we attempt to assess the tempo of land use. High-resolution chronometric determinations, for example, dendrochronology, offers one means for reading land use tempo. Indeed, Wills and Windes (1989) employ a sequence of tree-ring dates to partially support their reinterpretation of Shabik'eschee Village as representing periodic rather than two distinct occupations of a Chaco Canyon rim location. It is likely, however, that even dendrochronology, the dating method that affords the highest potential resolution, may be too coarse to monitor land use tempos of interest Also, tree-ring series that would enable the chronometric determination of locale use tempo have not been developed for all regions of the world.

Gilman's (1987) cross-cultural study of pit structure construction and use suggests that more indirect methods for reading tempo may be developed. She observes that pit structures were a common mode of habitation in circumstances with biseasonal mobility. Biseasonal mobility tethered to pit structures indicates one kind of land use tempo, with repeated, planned use of at least one location on a seasonal basis. Can we also detect repeated but unplanned use of an area or use that is sporadic but planned? Can we understand the tempo of use and in so doing be better able to distinguish one economic organization from another?

Redding (1988:85) suggests that determinations of exactly this sort .are necessary in order to archaeologically track subsistence change. He proposes that tactical changes in subsistence activities, that is, changes in the spatial and temporal dimensions of those activities, may herald a subsistence shift. Unfortunately, it is exactly this sort of change for which there are few archaeological indicators.

In the following, I propose to monitor land use tempo though a consideration of the spatial structure of archaeological deposits that show facility refurbishment, deliberate destruction, and apparent decay. Importantly, this proposition offers further insight into the variability in archaeological landscapes documented in this volume and elsewhere.

Systemic Locale Use Tempo and Archaeological Spatial Structure

In a 1986 article, Robert Dewar introduced the concepts of spatial congruency and temporal continuity to describe the settlement history of a location (see also Brooks and Yellen 1987 and Camilli 1983:74-132). *Spatial congruency* refers to the spatial displacement observed between occupation events with high spatial congruency equivalent to reoccupation with direct superimposition. *Temporal continuity* refers to the degree to which the same location is used through time and incorporates notions of occupation frequency and duration; high temporal continuity means that a location is occupied frequently with each occupation event a lengthy one.

Here, I wish to recast these concepts in terms of tempo of locale use and spatial structure of material remains resulting from occupation events. More critically, I propose to couple them and aim to demonstrate that certain tempos of place use and reoccupation will necessarily result in distinctive spatial distributions. When archaeologically documented, this spatial structure, in tum, may inform on the tempo with which an area has been occupied in the past.

Although the literature on this subject is not overly developed, it is important to be clear about several terms. Brooks and Yellen (1987:69) distinguish between *reuse,* redundant place use that is spatially congruent with previously established facilities, and *reoccupation,* repeated place use without spatial congruency. Camilli (1983:71-134) terms the same phenomena *reoccupation* and *multiple occupation,* respectively. Here, the terms *reuse* and *reoccupation* are used interchangeably to refer to repeated use of a locale; individual events mayor may not be spatially congruent with previous occupations.

Model of Locale Reoccupation

The claimed relationship between land use tempo, on the one hand, and spatial structure, on the other, can be described in terms of ethnographic "rules" for reoccupation. Vierra (1985) has distinguished between reoccupation for residential and special purposes. I propose a more functionally general model of reoccupation here but contrast those occupation histories accumulating in constrained (e.g., caves) versus unconstrained (most other places) spaces (see also Wills and Windes 1989:355).

Six different measures of time are important to this discussion of locale occupation history. The first two, reoccupation interval (RI) and reoccupation interval variation (RIV), describe the tempo of land use occupation and reoccupation. Their utility is illustrated in the computer simulation that we discuss later.

The remaining four, facility use-life, site use-life, site regeneration time, and facility decay interval, relate to characteristics of the location being occupied. Facility use-life (FUL) refers to the amount of time a facility or structure endures and is useful in the capacity for which it is designed. Actual FUL is a function of many things such as functional design criteria (Hunter-Anderson 1977), perceived maintenance versus construction costs (McGuire and Schiffer 1983), and expected total use-life (Kent 1991; Hitchcock 1987), encompassing all anticipated future uses. In some cases, meeting the functional needs of anyone occupation event will result in a facility that endures beyond the total anticipated use-life of the facility.

Site use-life (SUL) refers to length of time a location may be used before becoming polluted or vermin-ridden, or, before the immediate environment becomes depleted of critical bulky resources. Expected site use-life, of course, determines hygienic practices (cf. Silberbauer 1972:303). Similarly, the nature of the economic organization, dictating and being reflected by the role of individual locations over the short and long term, stipulates site use-life.

Site regeneration interval (SRI) is the time it takes for the pollution problem to abate or for critical bulky resources to rebound. In Brooks Range in Alaska, for example, Binford's (1978:425) informants reported that willow stands, used as fuel by the Nunamiut and exhausted after 2 years of wintertime residency, required 45 years to regenerate.

Finally, the facility decay interval (FDI) is the amount of time after which no trace of the facility remains visible. For wooden structures in biotically active environments, this interval may be very small; masonry structures in an arid environment may have a decay time measured in centuries. The FDI may also be accelerated by humans scavenging materials for other uses (e.g., Lange and Rydberg 1972; see Wandsnider 1989:123-130). Also, facilities may be deliberately destroyed and the site abandoned upon the death of site occupant as related by numerous ethnographic accounts of hunter-gatherers.

Table 1 presents values for these measures for two groups, the western Kalahari !Kung and Amboseli Maasai pastoralists. The !Kung have been intensively studied over the past several decades with the consequence that there exists good information on many of these values. For example, the 1960s wet season camps documented by Yellen (1977) were usually occupied for very brief time periods (i.e., days) and one-quarter of the 16 locations mapped by Yellen were reoccupied. The reoccupation events occurred within the 1-year (Yellen 1977:67) use-life of the huts, and at least some of these huts were reused; others (built by individuals not part of the reoccupying group) were disassembled and used to build huts for new occupants. The tempo of the use of specific wet season campsites over the very short

Table 1. Values for Facility and Site Time Measures

Camp	FUL	FDI	SUL	SRI
!Kung (1960s)[a]				
Wet	Year	Year	Days/weeks	Seasonal recovery
Dry	Year	Year	6 months	3-5 years
Maasai pastoralists (1970s)[b]				
"Swamp-far"	Unknown	Unknown	3.7 years	20-25 years
"Near-swamp"	Unknown	Unknown	10 years	20-25 years

a. Sources: Brooks and Yellen 1987; Patricia Draper, personal communication 1990; Yellen 1977, 1986.

b. Source: Western and Dunne 1979.

term (i.e., months) is deliberate. Over the medium and long terms, however, it is seasonal, brief, and generally fortuitous (Brooks and Yellen 1987:87).

The dry season camp at Dobe also is occupied and reoccupied with deliberation, at least over the short term (Brooks and Yellen 1987:87). Occupation durations of between 1 and 22 months (9.89 ± 7.37 months) are reported by Yellen (1986:738), with occupants coming and going throughout the span of the site life. A dry season camp is abandoned "only if a death occurs there or it becomes extremely rank and bug ridden" (Yellen 1977:78). Given that Dobe is a reliable source of water even during the dry season and has been so for many centuries, reuse of a previously camp site is likely over the long term. In the medium term, that is, within the life span of occupants, it seems to have been very rare, as discussed later.

Western and Dunne offer little information on facility use-life or decay interval, noting only that huts and fences attained a poor state of repair after a long (length unspecified) time without occupants (1979:95). Such locations would be forsaken for others to avoid the 4-week labor cost necessary to making the corrals and huts serviceable. They provide relatively more information on site use-life. They note that after a period of 7 to 8 years, a settlement location would become saturated with the urine of the Maasai cattle, at which point drainage at the site was impaired, and the location became undesirable. In the short term, locations were left when the vegetation was depleted or when disease losses mounted (1979:95). Western and Dunne also note that the Maasai they studied would move six to eight times per year among settlements, with settlements in "swamp-far" areas with unpredictable resources being visited a minimum of six times over an average of 3.7 years. Settlements in "near-swamp" areas with forage that is highly predictable but of low quality were being used two to three times per year for up to a decade.

Taken together, these measures reflect the tempo of use received by a location, which in tum informs on the organization of the settlement -subsistence system in that particular environment. In the same environment, a different settlement -subsistence configuration would result in places playing different roles and hence, different values for these temporal measures would be evident. If we had such values for every part of the used landscape, then we would have a very effective currency with which to compare and contrast the configurations of land use systems through time. Indeed, efforts to characterize the archaeological landscape in terms of number of residential-camp versus special-purpose sites (e.g., Upham 1984) are attempting exactly this.

This effort does not attempt to identify archaeological indicators that inform on each of the four individual temporal measures. I also will not address the probability that the archaeological record does not always instruct on which cultural system is making use of a locale, although it perhaps can tell us "one only" or "more than one" system. Instead, I will consider the archaeological consequences of place use tempo with respect to these different measures.

Rules for reoccupation are derived from the ethnographic accounts and are presented in here terms of computer language-like if-then statements. For place use in a situation where space is not constrained, they are:

1. *If the facilities are in good repair and the site is not polluted and resources are not depleted, then reuse both the facilities and the site.* Reoccupation in this case acknowledges the serviceable state of the' facilities and site by reusing or refurbishing previously constructed facilities. Examples of this type include the reoccupation of !Kung Camp 1 one month after its abandonment (Yellen 1977); the huts and hearths previously constructed were employed upon reoccupation. Yellen also recorded several other camps (3, 4, and 7) that were reoccupied in which some facilities were reused and others were dissembled and used in building new huts to accommodate newcomers.

2a. *If facilities are in good repair, but site-life has been exceeded, then avoid the site, possibly moving the facilities to a new site location.* Reoccupation acknowledges the previous occupation by avoiding the site or reusing it for very brief visits. Binford's (1978:170) description of reuse of a Nunamiut residential camp, where firewood has been depleted through intensive wintertime occupation, by a small hunting party for a very short span is an example of the second case. Examples of the first case are rare, although accounts of locations being abandoned because site use-life has been approached are common. For example, Denham (1972) describes an Alyawara community shifting between boreholes about every 2 years, as firewood becomes more costly to transport.

2b. *If facilities are in poor repair, but the site is habitable, then conditionally scavenge materials from decaying facilities and move to new position on site.* Reoccupation acknowledges the previous occupation by avoiding specific facility locations at a site. For example, Gould (1980:10) describes Ngatatjara aboriginals, upon arriving at a previously visited water source, scavenging firewood from a decaying sunshade located 30 m from the water source and about 190 m from the new facility location. This same situation may also apply to the continuous use of a site by a group, in which the site use-life is not exceeded but facility life is exhausted. O'Connell (1987:87-88) reports 21 Alyawara households building 105 shelters at 104 locations over an 11-month span, with structures being repositioned because of death, accommodation of visitors, shelter deterioration, domestic strife, and other factors.

2c. *If facilities are in poor repair and site-life has been exceeded, then avoid the location, possibly scavenging material for use elsewhere.* Reoccupation acknowledges previous occupational remains by avoiding both facility and site, and, conditionally scavenging from facilities. Again, few accounts of this aspect of reoccupation have been explicitly documented because ethnographers typically document where a group resides, rather than where it chooses not to reside.

3. *If facilities have decayed and the site is in good repair, then the previous site of a facility or encampment is available for occupation.* Reoccupation does not acknowledge invisible (e.g., subsurface) remains from previous occupations either by avoidance or by deliberate selection. The cultural landscape, however, is populated with locations to which cultural memories are attached, and this knowledge may attract or repel subsequent occupation. For example, Patricia Draper (personal communication 1990) reports that the locations at which !Kung individuals had been buried may be avoided for several months after the death, but this avoidance does not persist beyond that time. The 4-km^2 area around the Dobe waterhole in the western Kalahari Desert has been a preferred dry camp location for centuries. Within this area, Brooks and Yellen (1987:88) note the reuse of only two locations during the 40-year observation period. In one case, 15 years had transpired between occupation events, during which time the bush had recovered and all obtrusive evidence of the previous occupation had disappeared.

These reoccupation generalizations assume a different form in the situation of socially or physically constrained space. At locations that are preferred but have constrained space, facility maintenance and refurbishing is frequently reported. For example, Solecki (1979:327) describes the repair and reconstruction of huts and corrals by the 1950s Kurdish occupants of Shanidar Cave. A Nunamiut sheep-observation stand reported by Binford (1978:408) is an example of a very specialized, open-air, location that has been used and maintained for generations. The scars of repeated place use by Maasai, whose cattle have settlement requirements met by only a few locations on the landscape (Western and Dunne 1979:95), is evidence of this kind of repeated use history.

When decayed and decaying remains are found at these constrained spaces, the facilities may be destroyed and removed or disassembled and reused. For example, upon reoccupying a cave that has seen previous use, the Alyawara have been observed to burn the extant rubbish, spreading the ash on the surface to create a "clean" surface (Binford, personal communication, cited in Vierra 1985:70). For a Mackenzie Basin Dene group residentially confined to a small spit, houses of frequently disassembled and reassembled nearby, and the residential trash amassed and burned (Janes 1983:29-34).

Although these reoccupation generalizations have been phrased in terms of rules, the basis for why they hold is both axiomatic and theoretically based. To date, humans and their devices are confined to the three dimensions of space and the fourth dimension of time. It is impossible for two solids to exist in the exact same place during the exact same time. Therefore, to occupy a location at which a facility is found entails that either the existing facility be occupied as is, be refurbished, or be destroyed and rebuilt A final alternative is to avoid the location and build a facility elsewhere. The tactical decision about which of these options to implement seems to be based on cost-benefit determinations. The first option appears to be taken when the facilities are still in "good" repair (no cost); the second, when only minor repair is required (small cost); the third when the location (e.g., a cave) offers special characteristics (absorption of large costs warranted by other benefits); and, the fourth when refurbishment is deemed too costly (see Yellen 1976:58-59). Support for these statements comes from interviews with anthropologists (Patricia Draper, personal communication 1990; Henry Harpending, personal communication 1990) and ethnoarchaeologists (Lewis Binford, personal communication 1990; Robert Hitchcock, personal communication 1990; John Yellen, personal communication 1990) on the abandonment and reoccupation of facilities and sites by groups whom they have studied for other purposes. In fact, little directed research on this topic has occurred and would greatly benefit the understanding of why these generalizations appear to hold.

Recurrent locale use over the short term results in a cultural landscape that is variably rich in abandoned and decaying facilities. McGee's (1898) description of the Seri Indian cultural landscape, with which this chapter opens, nicely illustrates this aspect of the prehistoric landscape. John Wesley Powell's oft-cited report of a Ute camp (see Fowler and Fowler 1971:53), with an extensive distribution of abandoned structures giving an impression of a camp a magnitude larger than it actually was, is another provocative example (see also Woodburn 1972:194). Conversely, Cipriani writes for the Onges on Little Andaman island that "since the same small, well-chosen site may be used for thousands of years, the hut ends up perching on top of a small mound of refuse dating back to ancient times" (1966:54).

The archaeological consequences of these reoccupation rules holding over the long term, developed in the following section, are several and impact both number and distribution of facilities as well as the degree to which they have been refurbished or maintained.

Locale Reoccupation Simulation and Results

The long-term effects of locale occupation and reoccupation in unconstrained space according to the preceding model are illustrated here through computer simulation.[1] In this exercise, the focus is on facility uselife (FUL) and facility decay interval (FDI), and the interplay of these two

1. The simulation was written in Borland Turbo Pascal version 5.0 and is available upon request from the author.

with the reoccupation interval (RI) and reoccupation interval variation (RIV). Occupation of a near-water locale over a series of 100 occupation events was simulated, with the settlement pattern described by Tindale (1972:244) for the Pitjandjara in the vicinity of ephemeral water serving as a model. The near-water locale, measuring 1,000m × 1,000m, was considered a plain, homogenous in all regards except that of previous or extant occupation debris. With every occupation of the near-water locale, a decision about which of the countless locations to occupy was made based on the state and locations of previously used facilities, but, occupation was elastically constrained to occur within 200 m of the water source.

If reoccupation occurred within the life span of an extant facility, it was reoccupied. If the use-life of a facility had been exceeded, but the facility persisted in a deteriorating state, occupation was constrained to any area 75 m to 200 m away that still fell within the vicinity of the water source. This 75 to 200-m "shifting" distance is commonly mentioned in hunter-gatherer ethnographic accounts (e.g., Woodburn [1972:194] for the Hazda; Yellen [1977:78] for the !Kung); Western and Dunne (1979:95) note for the Maasai pastoralists they studied a shifting distance of several hundred meters. This shifting distance seems to be a compromise between remaining near the desired location, such as a water source, but "far enough" from the abandoned facilities. It is unclear if matters of hygiene or relative abundance of other critical resources such as firewood are responsible for how far is "far enough." If preexisting facilities had decayed to a point where their presence was no longer detectable, then occupation location was randomly determined. Reoccupation occurred according to a specified time interval that was allowed to stochastically vary within predefined limits.

In this simulation, time is measured in relative units. As will be shown later, it is not so much the absolute value of the time units that impacts the character of the distribution of occupation remains, but the values of the facility use-life, decay interval, and reoccupation intervals relative to each other. I nevertheless found it helpful to think of these time intervals in terms of months.

With every occupation, it was assumed that obtrusive, but perishable materials were deposited as well as unobtrusive, but relatively eternal materials. That is, with every occupation event, perishable structures would be constructed at the same time that artifacts were deposited and hearths excavated and used. Upon abandonment, hearth features and durable artifacts would persist even after facilities like sun and wind shelters had decayed or been scavenged. The archaeological landscape of the American West, for example, is resplendent with such enduring features and artifacts, reflecting occupations of varying durations and tempo.

On completion of the simulated occupation history, what does the distribution of these persistent (but unobtrusive) materials look like? Figures 1 through 4 present examples of the completed simulations for four

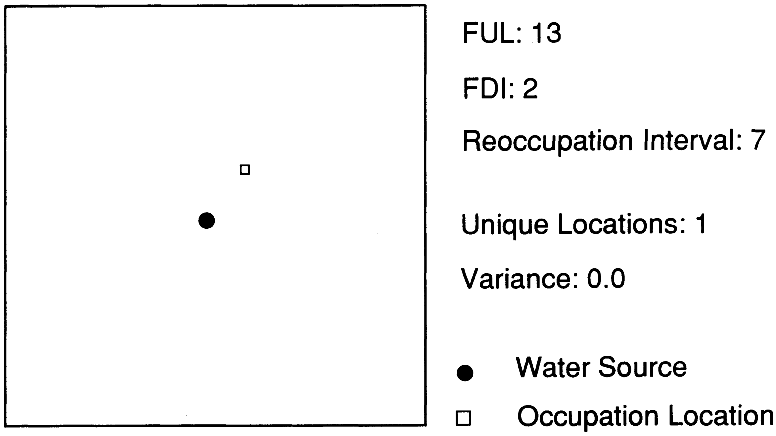


Figure 1. Simulated locale reoccupation with deliberate superimposition.

different situations. In the first (Figure 1), reoccupation always occurs at an interval inside that of the use-life of the facility, which is continuously refurbished. Only one unique location was occupied (and presumably well maintained) and is "archaeologically" recognized.

In the second situation (Figure 2), reoccupation usually occurs after the use-life of the facility is exhausted and the facility has decayed. Of the 100 occupation events, 100 randomly determined (albeit constrained by the magnetic water source) locations were occupied. The variance of their distribution, determined with respect to the mean values for northing and easting, is 5,360.6.[2]

The third situation (Figures 3 and 4) considers reoccupation that occurs at an interval greater than the use-life of the facilities but less than the facility decay interval. In the case of Figure 3, the decay interval is almost twice that of the reoccupation interval. According to the reoccupation model, persistent deteriorating facilities preclude some locations from occupation, resulting in a more regular distribution of occupation locations. Again, 100 locations were occupied, and these are spatially distributed such that they have a variance of 12,717.4. Of note is that this variance is larger than that for the randomly determined occupation history depicted in Figure 2.

An even larger disparity between the reoccupation *(RI* = 5) and decay *(FDI* = 100) intervals was also simulated, the results of which are presented

2. Variance was calculated as:

$$var = \frac{\sum ((x - \bar{x})^2 + (y - \bar{y})^2)}{2N}$$

with x and y being the easting and northing coordinates and N the number of unique occupation locations.

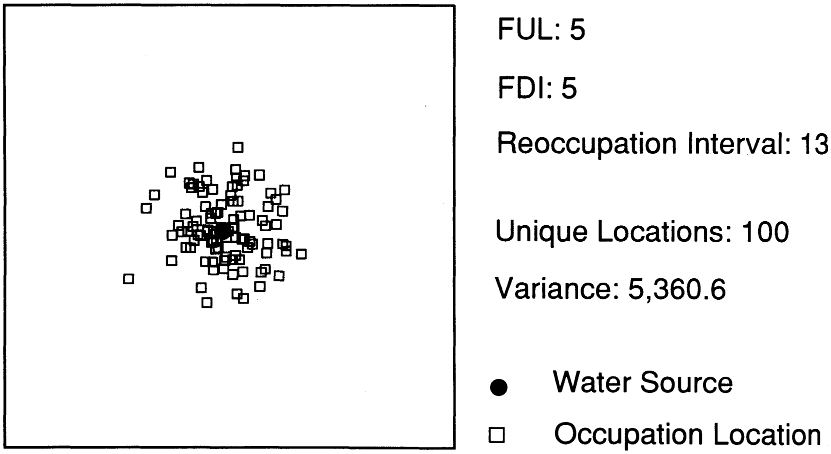


Figure 2. Simulated locale reoccupation with no deliberate superimposition and no avoidance.

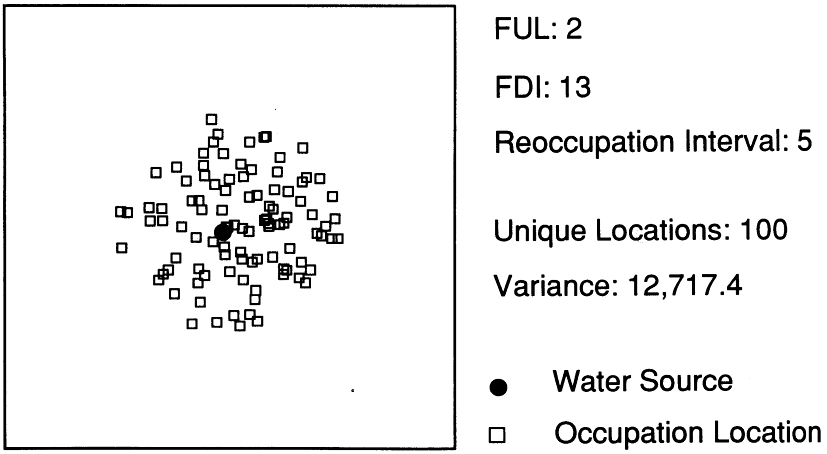


Figure 3. Simulated locale reoccupation with no deliberate superimposition and some avoidance (FDI is almost three times greater than RI).

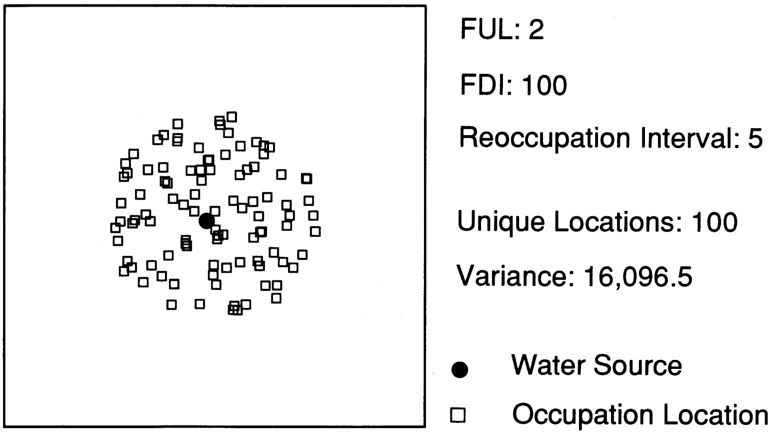


Figure 4. Simulated locale reoccupation with no deliberate superimposition and with avoidance (FDI is 20 times greater than RI).

in Figure 4. Here, the number of unique locations is again 100; their spatial distribution is even more regular, as reflected by the still larger variance (16,096.5).

This preliminary analysis suggests, then, that number of occupation locations and their distribution, whether random or regular, reflects occupation tempo, at least with respect to *FUL* and *FDI.* This relationship is further explored through more extensive simulation. A simulation was run for all combinations of the values of 1, 3, 7, 13, and 27 for each of the parameters of *FUL, FDI,* and *RI. RI* was allowed to stochastically vary as well through incorporation of a normal random variate that assumed the same (1, 3, 7, etc.) values. For each of the 625 different configurations of parameter values, 25 trials were run. Mean, minimum, and maximum variances and mean number of occupation locations were recorded for each set of 25 trials.

Figure 5 presents the results of these multiple trials as described by mean number of unique occupation locations and the mean variance of their spatial distribution for only those trials in with a minimal amount *(RIV* = 1) of stochastic variation in reoccupation. Minimum and maximum variance is not treated here because it mirrors the results reported for the mean variance in spatial distribution. In this graph, six clusters of remnant settlement patterns, corresponding to six relationships between *FUL, FDI,* and *RI,* are found.

1. *FUL* > *RI* > *FDI*: In the case where reoccupation primarily occurs within the life span of the facility, one or at most two well-maintained occupation locations results. With this total superimposition

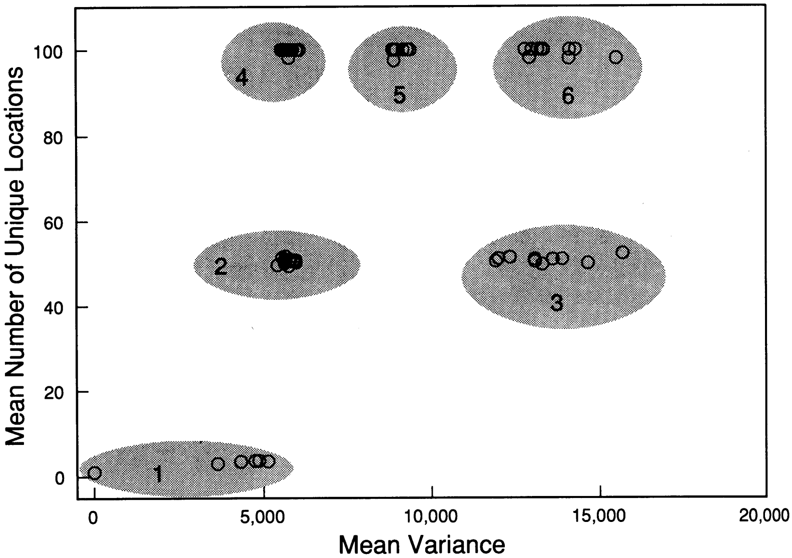


Figure 5. Summary of 125 sets of simulated locale reoccupation (RIV = 1; see text for interpretation of numbered clusters).

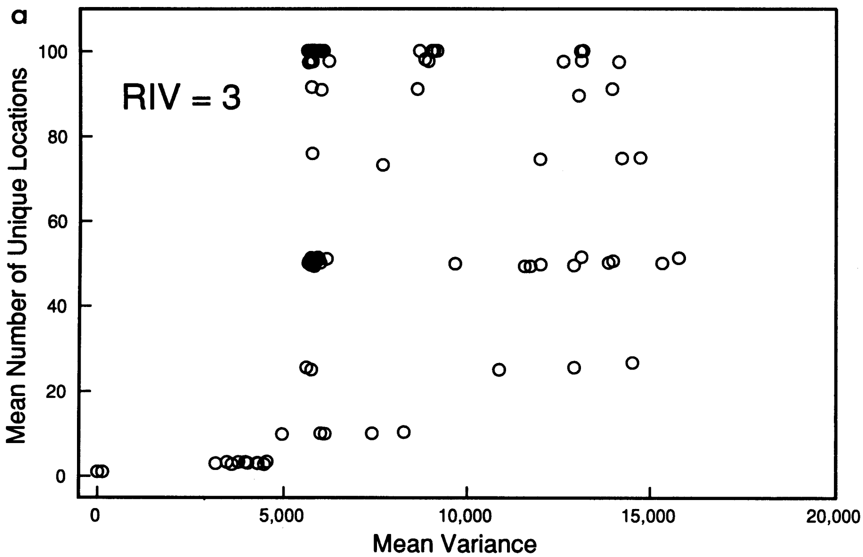
of occupation events, a variance of zero is seen. The five settlement patterns with occupation location variance of around 5,000 are those in which stochastic variation resulted in reoccupation outside the use-life of the facility. In these few cases, an additional facility was constructed at another locale location. The small facility decay interval means that few facilities persist through time to determine subsequent occupations in the area. Thus the magnetic quality of the water source is the sole determinant of occupation. In this simulation, variance values of between 5,000 and 6,000 are expected with randomly determined locale reoccupation, that is, local reoccupation without superimposition and without avoidance.

2. (*FUL* = *RI*) > *FDI*: In this case, the reoccupation interval is equal to the facility use-life and, as the actual variation in reoccupation is randomly distributed, half of the time results in reoccupation within the *FUL* and the other half of the time results in reoccupation just outside the use-life of the facility. For this reason, half of the occupations result in reuse of extant facilities, and the other half entail new facilities being built at nearby locations. Thus an average of about 50 occupation locations (out of 100 occupation events) is seen. For this cluster, facility decay interval is small so that previously occupied locations exert little influence over which locations are occupied. That is, like the first situation, reoccupation is a randomly determined, and variance is therefore between 5,000 and 6,000.

3. *FDI* > (*FUL* = *RI*): This situation is similar to situation 2 in that reoccupation occurs sometimes within facility use-life and other times outside of it. It differs in that abandoned facilities persist through time and thus influence which locations are available for reoccupation. For this reason, the variance recorded for the easting and northing coordinates of the occupied locations increases to above 12,000. As mentioned for Figures 3 and 4, the degree of regularity (as measured by variance) increases as facilities persist for longer time periods, relative to the reoccupation interval.
4. *RI* > *FDI* > *FUL*: In this situation, reoccupation occurs after reparable facility use-life is exhausted. Therefore, reoccupation mostly results in the construction of new facilities, and we see a unique occupation location for almost every of the 100 occupation events. These locations are essentially randomly determined, however, because facilities do not persist to influence subsequent occupations.
5. (*FDI* = *RI*) > *FUL*: This situation is similar to situation 4 except that specified reoccupation interval is equal to the facility decay interval. As actual reoccupation interval is modulated by stochastic variation that is normally distributed, half the time this results in reoccupation with standing facilities preventing reoccupation of certain locations; and half the time, no facilities persist to deflect reoccupation of a specific location. Thus an intermediate variance of about 8,000 is seen.
6. *FDI*> *RI* > *FUL*: Finally, this last situation is likewise similar to situations 4 and 5 in that facility use-life is very small compared with reoccupation interval. Because the facility decay interval is relatively large, however, facilities persist to deflect any potential reoccupation of the same location. Thus a more regular (variance> 12,000) distribution of occupied locations is seen.

In sum, the number of occupied locations reflects the relationship between facility use-life and reoccupation interval. When reoccupation occurs within the use-life of extant facilities, then a single location may continue to be occupied. When reoccupation occurs at an interval greater than the facility use-life (no matter the length of the facility use-life), then new locations will be selected, resulting in higher numbers of locations bearing evidence of occupation.

Concomitantly, high variance in the distribution of occupied locations is seen when facility decay interval, the time it takes for a facility to decay, is also high. The longer the decay interval *relative to the interval at which a locale is revisited,* the greater the observed variance. Variances of about 5,000 reflect randomly determined occupation locations. Intermediate values reflect reoccupation that is sometimes determined by persisting facilities and other times is not.



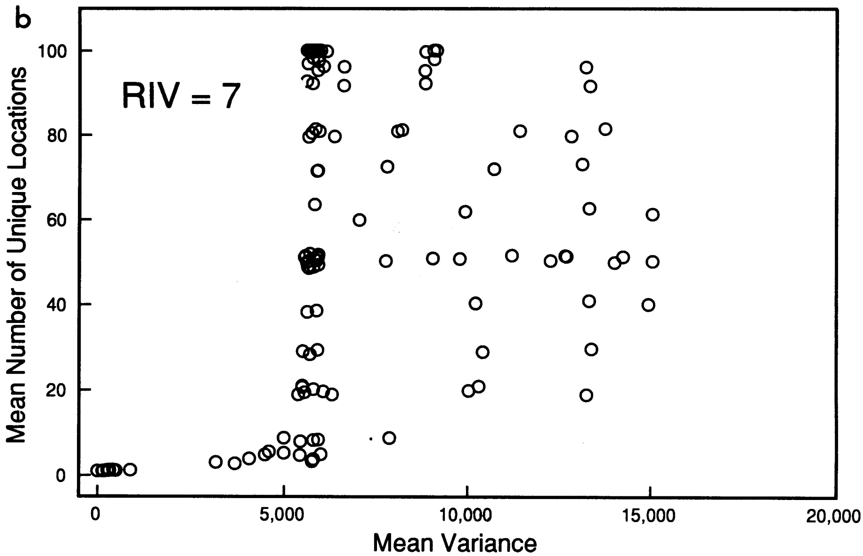
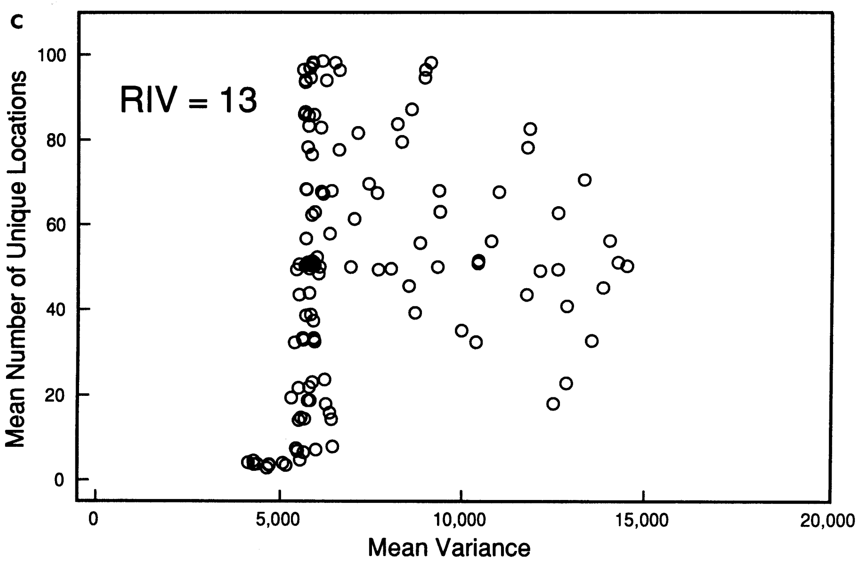
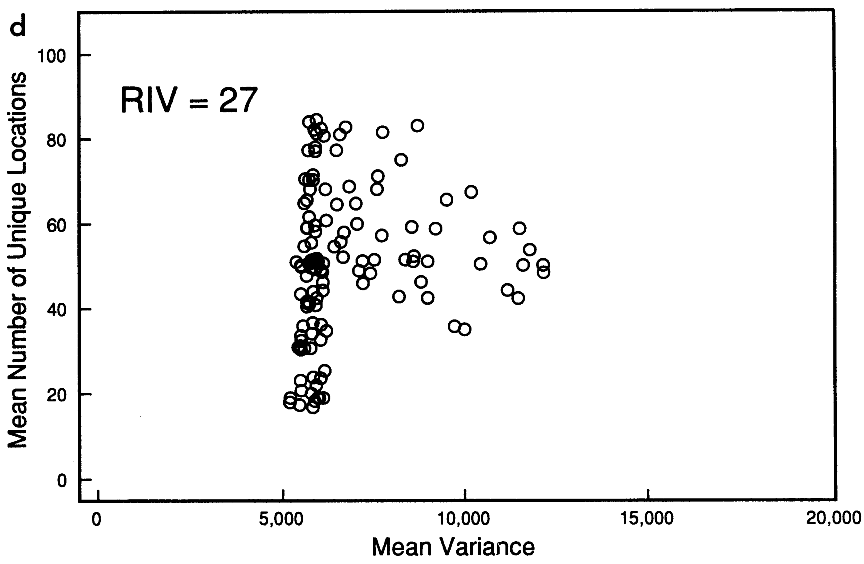


Figure 6. Summary of 125 sets of simulated locale reoccupation: (a) RIV = 3; (b) RIV = 7; (c) RIV = 13; and (d) RIV = 27.


c
RIV = 13
Mean Number of Unique Locations
100
80
60
40
20
0
0
5,000
10,000
15,000
20,000
Mean Variance


d
RIV = 27
Mean Number of Unique Locations
100
80
60
40
20
0
0
5,000
10,000
15,000
20,000
Mean Variance

In that reoccupation in the real world is often tied to other events (e.g., rainfall, hunting success, and so forth) best modeled in terms of stochastic variation, it is useful to consider the effects of variation in reoccupation of the simulated water source locale. The different graphs in Figure 6 correspond to an increasing value for permitted stochastic variation in reoccupation interval. The settlement patterns summarized in Figure 5 reflect a specified reoccupation interval plus a value randomly drawn from a normal distribution with a mean of 0 and a standard deviation of 1, resulting in actual reoccupation intervals that vary little from the specified value. In Figures 6a-d, the mean of the normally distributed random variate added to the specified reoccupation interval is also 0; the standard deviation, however is 3, 7, 13, and 27, respectively. Thus Figure 6a represents a locale that is reoccupied in an almost regular fashion, whereas Figure 6d shows the results of reoccupation for which the interval varies dramatically. The relationship between *FUL, FDI,* and *RI* discussed for Figure 5 and the effects of these with respect to number of unique occupation locations and variance hold here as well with the addition of one other cluster (see Figure 6a). This is the situation in which facility decay interval exceeds facility use-life, which also exceeds reoccupation interval (i.e., *FDI* > *FUL* > *RI*). In this case, facilities are created at few unique locations because for the most part, facilities are in good repair and can be reused. When facilities are found to be in poor repair, then a new location is selected. Because the facility decay interval is relatively high, however, certain locations are not available for reoccupation, and a more regular (higher variance) is seen.

Considering all of Figures 6a-d, one trend can be noted. That is, as the occupation interval increasingly varies, the range in the number of unique occupation locations changes from 0–100 to 15–85; where the distribution was previously trimodel, with modes at 0, 50, and 100, it becomes unimodel, with a single mode at 50. Simultaneously, the range in variance values shifts from 0–16,000 to 5,500–12,000. Thus, with locale reoccupation that varies dramatically, we see both reuse of locations as well as construction of new facilities. As reoccupation sometimes occurs in the presence of persistent but decaying facilities and sometimes does not, intermediate amounts of variance in the distribution of occupied locations is observed. Figure 5 (and 6a) reflects reoccupation that may occur in a very stable or predictable environment; Figure 6d presents the long-term results of a highly variable reoccupation interval, as might hold in arid areas that experience spatially and temporally stochastic rainfall.

Figure 7 reiterates the information presented in Figures 5 and 6, summarizing the relationships among and between *RI, FUL,* and *FDI.*

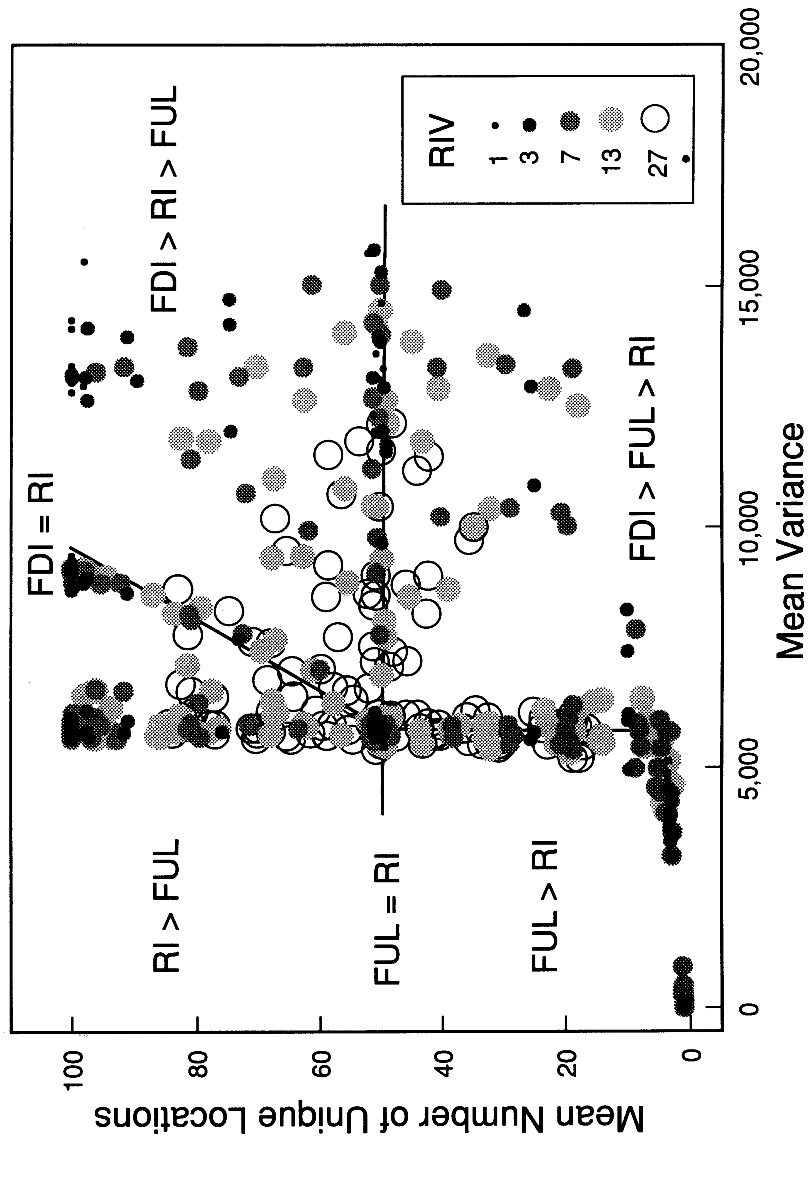


Figure 7. Summary of all simulations of locale reoccupation.

Discussion

This analysis suggests, minimally, that the *relationship* between facility use-life and decay intervals and reoccupation intervals may be inferred through inspection of the number and spatial distribution of occupations found in an area. With knowledge obtained from ethnoarchaeological and ethnographic research on values for the *FUL* and the *FDI*, the reoccupation interval itself might be determined. Such conclusions depend on several critical assumptions, however.

One such assumption is that occupants always behave as described by these empirical generalizations, that is, "rules" for reoccupation. It is likely, however, that such rules apply situationally rather than universally. Therefore, the question becomes under which circumstances do occupants reoccupy still useful facilities if they exist? If the facilities are judged too costly to repair (and what is "too costly"?), but occupation of the locale is desired, how variable is the role that extant but deteriorating facilities have in determining which location to occupy? These are questions that can be addressed through targeted ethnoarchaeological research.

These questions have guided the research I recently initiated on the development of archaeological landscapes over the medium term. The research focuses on the use, abandonment, and reuse of locations by nomadic pastoralists in south-central India. Some preliminary observations emanating from this continuing research are pertinent (Wandsnider 1991).

First, when reoccupation was observed, and, because of an abbreviated observation period only three such reoccupations were observed, it occurred at locations that had previously seen minimal (occupation length of days or weeks within a 6-month period) rather than intensive use (occupation length of months within a 6-month period). At the reoccupied locations, facilities, in the form of boulder platforms on which bulk food is stored and over which tents are erected, were present In all but one case, the facilities were ignored or avoided, with new facilities constructed amid the persisting facilities. I speculate that the reason why the persistent facilities of boulders were not reused relates to two factors. The first is that sheep herd size varies between occupations received by specific locales and the tent configuration (and hence boulder platform configuration), designed to enclose and protect the sheep during the night, must be constructed to accommodate the current sheep herd size. Persisting, serviceable boulder platforms may not fit the required current tent configuration.

The one case in which a previous facility was acknowledged by the new occupants informs on the second potential factor determining facility reuse—hygiene. Upon reoccupation, one boulder platform was disassembled, moved 1 meter and reassembled. The immediate area of the platform, which had been strewn with debris from the previous occupants, was also cleaned up. Thus hygienic concerns may be of some importance in determining facility reuse. Schebesta's (1973:56) observation that the Malay forest pygmies he documented in the early 1900s preferred new shelters to apparently serviceable structures may be interpreted in this light. It may also reflect, however, a decision on the part of the pygmies that refurbishing was more costly than building anew.

The reason this one boulder facility received the attention it did is, I conjecture, because of its preferred location. It is located at the intersection of two boulder walls, which are also used to contain the sheep. In fact, in all the encampments inspected, "corner" locations always contain a boulder facility, suggesting that they are preferred locations. To make use of this apparently preferred corner location, thus, the shepherds could have just employed the existing platform, but, instead, elected to rebuild it, perhaps for hygienic reasons as indicated. Stafford and Hajic (this volume) introduce the concept of landscape element, which allows us to talk about a landscape in terms of criteria that make some portions "preferred" and, with respect to other criteria, recognize still other preferred locations.

Through actualistic research, it is possible to evaluate the assumptions of the proposed reoccupation model and to learn about the circumstances where it does and, more important, does not track reality. It is likely that we will reach, if and when such research is completed, a conclusion similar to that emerging from research conducted on bone transportation and butchery practices (see Hudson 1992). That is, that decisions about facility reuse or relocation are indeed logical, but, that the content of those decisions is highly contingent on other features of the social and physical environment and on future plans, which are not directly accessible to the archaeologist This anticipated conclusion does not mean that such research would be conducted in vain. Rather, it signifies to me that research on the medium-term consequences of reoccupation will help us define the parameters of what we do not know about how archaeological landscapes develop (see Chang, this volume, for similar sentiments).

Another critical assumption that must be made if one is to infer locale use tempo from the number and variance in occupation locations is that we can archaeologically detect and identify unique occupation locations. There are two parts to this question. The first is that an accurate and reliable portrait of regional occupation is required. Current archeological field practices cannot guarantee this, and further effort in this area is absolutely necessary (e.g., Cowgill 1990; Wandsnider and Camilli 1992).

Second, even if we had such a high-fidelity archaeological representation, can unique occupation locations be archaeologically recognized? The answer seems to be, contextually, yes. In situations that have not seen reoccupation with overlap or superimposition, we may expect discrete (Chatters 1987:346-347; but see Brooks and Yellen 1987) distributions of features and artifacts and artifact distributions that manifest spatially distinctive size sorting (O'Connell 1987; Simms 1988, 1989; Thomas 1986;

Wandsnider 1989:173-216). At a location with a more complex occupation history, the character of the palimpsest will be informative in telling us "more than one occupation event occurred here." Work by Camilli (1983, 1988), among others, focuses on this issue, and the chapters by Stafford and Hajic and by Dewar and McBride (this volume) speak to recognizing and analyzing deposits of this kind.

In addition, the analysis presented here directs attention to the degree and kind of facility refurbishment or destruction, both at individual locations and throughout a locale. Enduring and maintained facilities are expected in the situation with relatively few other occupied locations. In the case of the more random distribution of facilities, little maintenance is to be expected. When occupation location variance is high, as in the case of decaying features that persist on the landscape, little maintenance is likewise to be anticipated.

Other analytic challenges must be solved before tempo can be inferred from spatial structure of archaeological remains. For example, the simulation here focuses on the case in which a point resource attracts occupation, with the probability of a particular location being occupied falling off as distance to the point water source increases. As described by Tindale (1972), such occupations by the Pitjandjara are very brief and tied to unpredictable rainfall events. The role played by other point resources in the landscape economy may be very different. Brooks and Yellen (1987), for example, have characterized occupation in the vicinity of Dobe such that a doughnut of occupation debris has accumulated around the waterhole, with the immediate vicinity of the hole being relatively free of debris. This pattern has resulted from the practice of not camping for long periods of time at the waterhole itself, which would discourage its use by animals in the area. Thus the uses to which all point water sources are put are not equal and should be reflected by the spatial structure of locale archaeological remains.

Additionally, the patch size and shape of resources that attract occupation will influence how the structure of archaeological remains develop there. That is, the archaeological spatial structure in the vicinity of a point resource that is being visited as frequently as a linear (e.g., rivers, trails) resource or an areal (e.g., stands of grasses or mesquite trees) resource will likely be very different by virtue of the geometry of the resource. Thus the variance measure used here to describe randomness or regularity of occupation remains has low general utility. Ebert's (1992) technique for describing frequencies and associations among artifacts at multiple scales, while yielding less than intuitive results, is likely much more useful.

Even if all of these assumptions could be warranted and analytic questions of how best to describe archaeological spatial structure were resolved, it is still unlikely that we would be able to simply read land use tempo from a graph of unique locations versus spatial variance, such as

Figure 8. Such attempted determinations, however, could provoke other productive research. For example, if a random distribution of highly visible monuments are found in close proximity to each other, a situation not documented ethnographically in repeated use of an area, we may suspect that the features come from a strictly contemporaneous occupation and proceed with analysis to reject or support such a finding.

Conclusions

As archaeologists confronted with a wind-swept, seemingly vacant expanse, it is sometimes difficult to remember that the landscape visited and used by prehistoric occupants was not a barren land. It was rich with cultural (as well as natural) features that constrained and influenced to varying degrees the subsequent use of entire locales as well as specific locations.

This chapter has attempted to explore the ramifications of differentially enduring features of cultural geography in the medium- and long-term development of archaeological landscapes. I have proposed a simple model that relates tempo of locale use, relative to the persistence of cultural features, to distinctive distributions of remains from reoccupation events. The relationship between past locale use tempo and present archaeological spatial structure, however, is likely to be much more complex than entertained here. Thus this paper has also identified several domains where actualistic and analytic research is necessary to develop our understanding of these complexities.

The spatial dimension of time informs on the tactics of land use for individual locales. In amassing such information for locales from throughout a region, we may construct a composite picture of land use strategy and economic organization. The resulting more detailed picture of the settlement-subsistence system should permit a fuller understanding of the ecological environment within which past selective forces operated.

Acknowledgments — This chapter is a result of discussions with numerous individuals, including Eileen Camilli, Zarine Cooper, James Ebert, Richa Jhaldiyal, Signa Larralde, K. Paddayya, Sheena Panja, Jackie Rossignol, Sarah Schlanger, Sarah Tarlow, and Patrice Teltser. I also consulted with Lewis Binford, Patricia Draper, Henry Harpending, Bob Hitchcock, Jean Hudson, and John Yellen. Amy Spiess provided technical assistance. I thank these individuals for their insights and remain responsible for errors in reasoning and presentation. The work reported upon here was supported by the Visiting Scholar program at the Center for Archaeological Investigations at Southern Illinois University Carbondale, the Fulbright Fellowship program of the Institute for International Education, Deccan College Post-graduate and Research Institute (Pune, India), and the University of Nebraska–Lincoln.

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